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METHOD FOR ADJUSTING THE CONCENTRATION OF A HYDROPONIC SOLUTION
[Suiko yo yoeki no nodo chosei hoho]

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1. Title of Invention

Method for Adjusting The Concentration of A Hydroponic Solution

2. Claim(s)

A method for adjusting the concentration of a hydroponic solution characterized by being provided with a pH and EC sensor which detects the acid and alkali concentration pH and the culture solution concentration EC of a culture solution in a hydroponic vessel, and a fertilizer tank which supplies fertilizer into this culture solution, and when the acid and alkali concentration pH detected by the aforesaid pH sensor exceeds a preset range, a fixed amount of the culture solution is discharged from the aforesaid vessel so that the fertilizer is replenished in an amount corresponding to the decrease in the culture solution concentration EC simultaneous to replenishing it with the same amount of raw water.

3. Detailed Specifications

"Field of Industrial Application"

The present invention relates to a method for adjusting the concentration of a hydroponic solution so as to hydroponically cultivate crops, such as leafy vegetables or fruits and vegetables, on a cultivation bed.

"Prior Art"

¹Number in the margin indicates pagination in the foreign text.

An automatic device for diluting and supplying a liquid fertilizer is disclosed in the publication of, e.g., Jitsukai JP-U No. S63-18015.

In addition, a means for controlling, respectively, the acid and alkali concentration pH and the culture solution concentration EC within fixed ranges, a means for judging that the composition of the culture solution has collapsed and replacing the entire amount of the culture solution with a new one when the acid and alkali concentration pH has fluctuated greatly from the initial value by only controlling the culture solution concentration EC but keeping the acid and alkali concentration pH open, among other means, are known for means for controlling hydroponic solutions that are normally employed in general.

"Problems to be Solved by the Invention"

However, with the first means for controlling the culture solution, as stated above, although both the acid and alkali concentration pH and culture solution concentration EC were initially controlled regularly, the situation was that a large amount of a strong acid or strong alkali was administered for adjusting the acid and alkali concentration pH, and there was a drawback in that the culture solution composition easily became unbalanced. In addition, with the latter means, not only were time and labor required for continually replacing the culture solution for crops where the fluctuation of the acid and alkali concentration pH was intense, /224

but a large amount of fertilizer was required for this replacement.

"Means for Solving the Problems"

Consequently, in the present invention is provided a pH and EC sensor which detects the acid and alkali concentration pH and the culture solution concentration EC of a culture solution in a hydroponic vessel, and a fertilizer tank which supplies fertilizer into this culture solution. When the acid and alkali concentration pH detected by the aforesaid pH sensor exceeds a preset range, a fixed amount of the culture solution is discharged from the aforesaid vessel so that the fertilizer is replenished in an amount corresponding to the decrease in the culture solution concentration EC simultaneous to replenishing it with the same amount of raw water.

"Effects"

Thus, according to the present invention, there is no troublesome time and labor or economical disadvantages for replacing all of the culture solution with a new solution when the acid and alkali concentration pH, as in the past, fluctuates greatly from a preset value, and so forth. The culture solution and acid and alkali concentration pH and the culture solution concentration EC, which are always stable, and the liquid temperature does not precipitously fluctuate can be obtained merely by replacing a small amount of the culture solution. In addition, since no strong acid or alkali is employed for adjusting the acid and alkali concentration pH, the composition of the culture solution does not become unbalanced. For

example, even if no acid or alkali solution is employed, the same advantages are manifested if the acid and alkali concentration pH is adjusted, while the acid/alkali concentration can be stabilized.

"Practical Examples"

A practical example of the present invention will now be described in detail on the basis of the drawings. Figure 1 is an overall explanatory diagram. 1 in the drawing is a culture solution tank which is the hydroponic vessel in which the culture solution is retained; 2 is a fertilizer tank in which fertilizer, such as composite and nitrogen compounds, are retained; 3 is a fertilizer pump P_2 which feeds the fertilizer in the aforesaid tank 2 to the culture solution tank 1; 4 is a water level sensor which supplies pure water, which is the raw water, through a solenoid valve 5 when the level of the culture solution in the aforesaid tank 1 is at or below a certain level; 6 is a pH sensor which senses the acid/alkali concentration in the culture solution in the aforesaid tank 1; 7 is a hydroponic pump P_1 which feeds the culture solution in the aforesaid tank 1 to a hydroponic cultivation bed 9 through a liquid feed pipe 8; 10 is a drainage solenoid valve which suitably discharges the culture solution in the aforesaid tank 1; 11 is a manual on/off valve for a cultivation bed interposed in the aforesaid liquid feed pipe 8; 12 is an acid and alkali liquid tank which retains the acid/alkali liquid to perform adjustment of the initial acid/alkali concentration of the culture solution in the aforesaid tank 1; 13 is an acid and

alkali liquid pump P_3 which feeds the acid/alkali solution in the aforesaid tank 12 to the culture solution tank 1; 14 is an EC sensor which senses the culture solution concentration EC of the culture solution in the aforesaid tank 1, which is so constituted as to supply the concentration pH- and EC-adjusted culture solution in the aforesaid tank 1 to the cultivation bed 9, and at the same time, is so provided to return the drainage discharged from the bed 9 to the tank 1 through a drain pipe 15, and by dipping the roots of crops into the culture solution in the aforesaid bed 9, growth thereof is performed.

As shown in Figure 2, a hydroponic control circuit 16 connected to the inputs of the aforesaid pH and EC sensors 6 and 14 and the water level sensor 4 is provided. This control circuit 16 is also connected to the outputs of the aforesaid hydroponic pump 7, fertilizer pump 3, hydroponic solenoid valve 5, and drainage solenoid valve 10, respectively, to perform drive and control of the pumps 3 and 7 as well as the solenoid valves 5 and 10 based on the detection by the aforesaid pH sensor 6, and is constituted to plan a regular maintenance of the acid and alkali concentration pH and the culture solution concentration EC in the tank 1.

According to the constitution as mentioned above, the effects of automatically adjusting the concentration of this culture solution will be described with reference to the flowchart in Figure 3 below.

In the hydroponic cultivation operation in which the acid and alkali concentration pH and the culture solution concentration EC of the culture solution in the aforesaid tank 1 is adjusted to the initial preset value, when the acid and alkali concentration pH value detected by the aforesaid pH sensor 6 is slightly over the upper and lower limits (e.g., 4.8 to 5.0 or 6.0 to 6.2) of a suitable range (5.0 to 6.0) (initial setting: about 5.5), the aforesaid drainage solenoid valve 10 undergoes an opening operation, the preset amount of the culture solution set between 10 and 20% of the culture solution in the aforesaid tank 1 is discharged, and when a preset amount of drainage thereof is detected by the water level sensor 4, the water supply solenoid valve 5 undergoes an opening operation. Simultaneous to pure water being replenished only in an amount nearly equal to the set amount of drainage, a prescribed tiny amount of fertilizer is replenished only to meet the decrease in the culture solution concentration EC by driving the aforesaid fertilizer pump 3. As a result, the acid and alkali concentration pH can be restored /225 to nearly the median value of the suitable range. Moreover, in this case, an imbalance in the composition of the culture solution caused by administering a strong acid/alkali so as to replenish the acid/alkali solution is prevented. In addition, in this case, by replacing the drainage that is 10 to 20% of the culture solution in the tank 1, the culture solution concentration EC remains

substantially unchanged and extra fertilization rarely needs to be performed.

"Advantages of the Invention"

As is evident from the above practical examples, the present invention is provided with pH and EC sensors 6 and 14 which detect the acid and alkali concentration pH and the culture solution concentration EC of a culture solution in a hydroponic vessel 1, and a fertilizer tank 2 which supplies fertilizer into this culture solution, and when the acid and alkali concentration pH detected by the aforesaid pH sensor 6 exceeds a preset range, a fixed amount of the culture solution is discharged from the aforesaid vessel 1 so that the fertilizer is replenished in an amount corresponding to the decrease in the culture solution concentration EC simultaneous to replenishing it with the same amount of raw water. Hence, remarkable advantages are manifested in that the troublesome time and labor and economical disadvantages of replacing all of the culture solution with new culture solution, and so forth, because the acid and alkali concentration pH fluctuates greater than a preset value, as in the past, is eliminated. A culture solution having an acid and alkali concentration pH and culture solution concentration EC that is normally stabilized without the liquid temperature precipitously fluctuating may be obtained merely by replacing a small amount of the culture solution. In addition, the culture solution composition does not become imbalanced since a strong acid or alkali is not employed

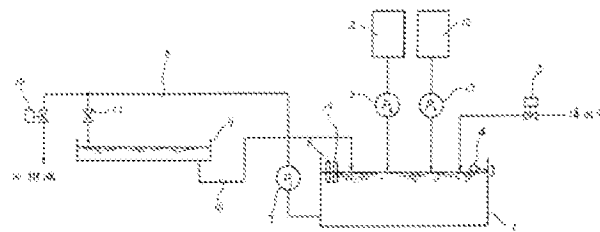
for adjusting the acid and alkali concentration pH. For example, the same advantage is manifested even if no acid/alkali solution is employed by adjusting the acid and alkali concentration pH. The acid/alkali concentration can be stabilized, and moreover, the majority of devices having a conventionally-known structure can be used economically, the operating efficiency can be improved drastically, etc.

4. Brief Description of the Drawings

Figure 1 is an overall explanatory diagram; Figure 2 is a concentration control circuit diagram; and Figure 3 is a flowchart thereof.

(1) culture solution tank (hydroponic vessel); (2) fertilizer tank;
(6) pH sensor; (14) EC sensor

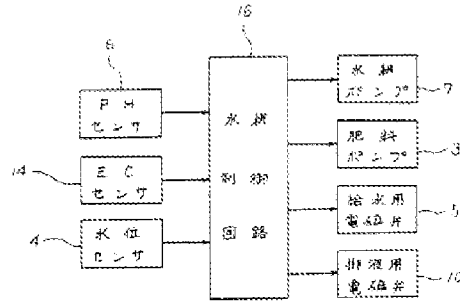
Figure 1



Key: (a) drainage; (b) pure water

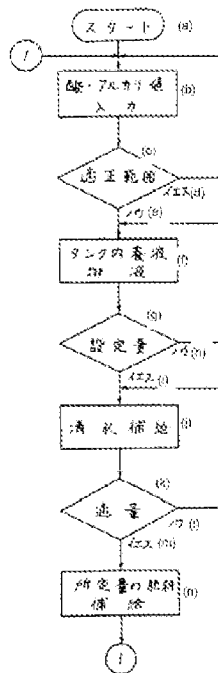
Figure 2

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Key: (6) pH sensor; (14) EC sensor; (4) water level sensor; (16) hydroponic control circuit; (7) hydroponic pump; (3) fertilizer pump; (5) water supply solenoid valve; (10) drainage solenoid valve

Figure 3



Key: (a) start; (b) Input acid/alkali value; (c) Suitable range; (d) Yes; (e) No; (f) Drain culture solution in tank; (g) Preset amount; (h) No; (i) Yes; (j) Supply clear water; (k) Proper quantity; (l) No; (m) Yes; (n) Replenish with prescribed amount of fertilizer